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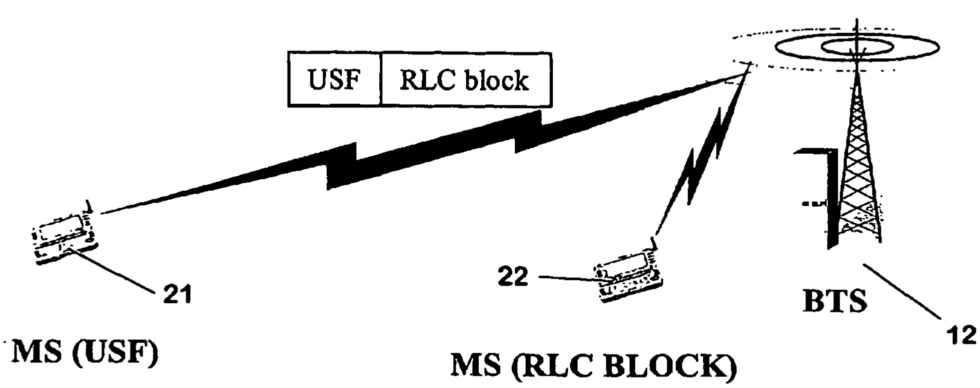

(57) **Abstract:** The invention relates to a method for controlling in a GPRS and/or EGPRS network 11-13 the power level employed for downlink transmissions from said network 11-13 to at least one mobile station 14, 21, 22. In order to enable such a power control, it is proposed that the method comprises adjusting the power level for a downlink transmission based on at least one measurement value indicating the quality of a radio link to be used for the downlink transmission to the at least one mobile station 14, 21, 22. The at least one measurement value was previously measured at the at least one mobile station 14, 21, 22. The at least one measurement value was previously measured at the at least one mobile station 14, 21, 22 for a preceding downlink transmission and transmitted by the at least one mobile station 14, 21, 22 to the network 11-13.

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Downlink power control

FIELD OF THE INVENTION

The invention relates to a method for controlling in a GPRS (General Packet Radio Service) and/or EGPRS (enhanced GPRS) network the power level employed for downlink transmissions from said network to at least one mobile station. The invention equally relates to a corresponding network, to a PCU (Packet Control Unit) for such a network, to a downlink power control algorithm for such a PCU and to a medium storing such an algorithm.

BACKGROUND OF THE INVENTION

GPRS is a communications system which enables the transmission of data end-to-end in packet transfer mode, i.e. without utilizing network resources in circuit switched mode. EGPRS enables in addition higher data rates than GPRS. Mobile subscribers can establish a connection with a GPRS and/or EGPRS network via a radio link to a base transceiver station BTS of the network. The BTS is part of a base station subsystem BSS of the network. Within this BSS it is connected to a base station controller BSC, which also provides an access to a core network.

In GPRS/EGPRS networks, a power control for the radio connections between a BTS and mobile stations is

important for achieving a high spectrum efficiency and a low power consumption. The main goals of a power control are to reduce cochannel interference and to increase the capacity of the system.

An implementation of uplink power control is known from the practice for GPRS. For implementing a downlink power control for GPRS/EGPRS, some GPRS specific aspects have to be taken into account.

In GPRS and EGPRS specifications, different methods have been described for managing the allocation of uplink radio blocks on packet data channels (PDCH) during a temporary block flow (TBF). A TBF is a physical connection used to support the unidirectional transfer of logical link control (LLC) protocol data units (PDU) on packet data physical channels.

In case a dynamic allocation of uplink radio blocks is implemented, the network has to assign each uplink radio block dynamically to a mobile station. To this end, a uplink state flag (USF) of 3 bits is transmitted in a downlink radio block to the respective mobile station to which an uplink radio block is to be assigned. Such uplink state flags are mentioned for example in the technical report 3GPP TS 04.60 V8.7.0 (2000-11): "3rd Generation Partnership Project; Technical Specification Group GSM EDGE Radio Access Network; General Packet Radio Service (GPRS); Mobile Station (MS) - Base Station System (BSS) interface; Radio Link Control/ Medium Access Control (RLC/MAC) protocol (Release 1999)".

The operator of a network will usually set a minimum power level with which the USF block has to be transmitted. This minimum power has to be guaranteed by the employed power control. Further, a power level is used by a BTS for an entire time slot employed in a downlink transmission. A USF block may share such a time slot with other blocks, in particular with a radio link control (RLC) block carrying user data. A USF block and an RLC block transmitted in a single time slot may be addressed to a single mobile station. But equally, the blocks can be addressed to different mobile stations located at different distances from the BTS. In order to ensure that both mobile stations receive the respective block correctly, the output power employed for the time slot has to be sufficiently high for a downlink transmission to both mobile stations.

SUMMARY OF THE INVENTION

It is an object of the invention to enable a downlink power control in an GPRS and/or EGPRS system.

This object is reached on the one hand with a method for controlling in a GPRS and/or EGPRS network the power level employed for downlink transmissions from the network to at least one mobile station. It is proposed that this method comprises adjusting the power level for a downlink transmission based on at least one measurement value indicating the quality of a radio link to be used for the downlink transmission to the at least one mobile station. The at least one measurement value was measured at the at least one mobile station for a preceding

downlink transmission and transmitted by the at least one mobile station to the network.

The object of the invention is equally reached with a GPRS and/or EGPRS network comprising a BSC connected to a BTS, via which BTS radio links are established between the network and mobile stations. The BSC comprises a PCU with means for adjusting a power level employed by the BTS for downlink transmissions according to the proposed method.

The object is further reached with a corresponding PCU, with a software constituting the proposed means for such a PCU, and with storing means in which such a software is stored.

A packet control unit PCU of some network element of a GPRS and/or EGPRS network can control the power level employed by a BTS for downlink transmissions to a mobile station. To this end, the PCU comprises means, in particular a downlink power control algorithm, for realizing the proposed method. The PCU can be located in particular in a BSC of the network, but e.g. as well at the BTS or at the GSN (GPRS Support Node) site.

The invention proceeds from the idea that in GPRS and/or EGPRS networks, downlink power control can be based on measurement values which are transmitted by the mobile station to the network and which indicate the current quality of the radio link to this mobile station.

The invention thus allows to adapt the output power to the respective radio link conditions. Accordingly, the output power can be minimized to a value which still ensures a good quality in the communications. Thereby, cochannel interference is reduced and the capacity of the system increased since a higher throughput per cell can be achieved. Also less interference is generated to speech services when GPRS/EGPRS is employed in the same band as speech.

Preferred embodiments of the invention become apparent from the subclaims.

In a preferred embodiment, if a quality level corresponding to received measurement values is higher than a predetermined maximum threshold value, the power level employed for downlink transmission is decreased by one step. If the quality level is lower than a minimum threshold value, the power level employed for downlink transmission is increased by one step. Minimum and maximum threshold values can be defined a priori by the operator of the network. Equally, the step size can be an internal parameter in dBs. It is to be noted that the step size can be different for increasing the downlink power level and for decreasing the downlink power level.

In a further preferred embodiment of the invention, it is ensured that the power level set for the downlink transmission of different blocks addressed to different mobile stations but transmitted with the same output power is high enough for each of the mobile stations by

selecting the most restrictive power level required by any of the mobile stations.

If a USF block is to be transmitted to a mobile station, there is not always a quality report from this mobile station for the radio link that is to be used for downlink transmission, and in case one exists, it might not have been updated for a while. In a preferred embodiment of the invention, therefore a timer is provided in the network for each mobile station in transfer mode. A timer is started when measurement values from the mobile station to which the timer is assigned are received by the network. When a USF block is to be transmitted, the power level is set according to the last received quality measurements and increased according to the time elapsed since these measurement values were received. In case no measurements are available from a mobile station to which a USF is to be transmitted, the maximum power is used for transmission.

In an equally preferred embodiment of the invention, a similar approach is used for the establishment of a new TBF. The power level that is to be used for the first transfer period of a new TBF is increased with the time that has passed since the transmission of the last transfer period of the previous TBF.

The same timer can be used for determining the power level to be employed for the transmission of USF blocks and for determining the power level to be employed for the first transfer period of a new TBF. The timer can be

either part of the PCU or the PCU has access to the respective timer value.

In case the new TBF uses another time slot or another transceiver of a BTS of the network for downlink transmission, the power could alternatively set to the maximum power level immediately.

The invention can use as quality level that is compared to predetermined threshold values any suitable value indicative of the quality of the radio link during the preceding transmission. Possible values are power levels, e.g. CIR (Carrier to Interference Ratio) values, or quality levels, like the reception quality (RXQUAL) for GPRS, and the mean bit error probability (Mean(BEP)) or the standard deviation of the bit error probability (std(BEP)) for EGPRS. Preferably, though, block error rate (BLER) values are used. BLER values constitute a better quality indicator than other parameters, since BLER values measure the bit errors after the error correction mechanism, whereas other quality parameters measure the bit errors before decoding. Using BLER values, changes in the efficiency of the error correction mechanism due to functionalities introduced in the network are taken into account.

BRIEF DESCRIPTION OF THE FIGURES

In the following, the invention is explained in more detail with reference to drawings, of which

Fig. 1 illustrates downlink power control interactions for a first situation according to an embodiment of the invention;

Fig. 2 shows a second possible situation in which a downlink power control according to the embodiment of the invention can be employed;

Fig. 3 is a flow chart for a part of a downlink power control according to the embodiment of the invention;

Fig. 4 illustrates the determination of BLER values for EGPRS and GPRS employed in the embodiment of the invention;

Fig. 5 illustrates the determination of the downlink power level to be used for USF blocks in the embodiment of the invention; and

Fig. 6 illustrates the determination of the downlink power level to be used for a new TBF in the embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows a part of a GPRS system enabling a downlink power control according to the invention.

In this system, a BSS of a random access network is formed by a BSC 11 and a BTS 12 which are connected to each other. The BSC 11, which comprises a PCU 13, provides an access to a core network not depicted in the figure. A mobile station MS 14 is further connected to the BTS 12 via an antenna of the BTS 12.

The mobile station 14 has an established downlink to the BSS and it performs quality measurements in the downlink. The measurement values comprise the reception quality and the signal variance. The mobile station 14 further filters the measurement values in order to avoid fluctuations due to temporal dependencies. The filtered measurement values are then transmitted by the mobile station 14 in a quality report via the BTS 12 to the BSC 11. The mobile station 14 transmits the measurement report to the BSS in 'packets downlink acknowledged/unacknowledged' messages. These messages are sent from the mobile station 14 to the BSS, when the BSS requests them from the mobile station 14.

Within the BSC 11, the PCU 13 is responsible for the downlink power control. To this end, a downlink power control algorithm is implemented in the PCU 13. When a packet with a quality report arrives from the mobile station 14 at the PCU 13, the included measurement values are collected. The algorithm then determines on the basis of these measurement values the output power that is to be used by the BTS 12 for a downlink transmission to the mobile station 14 in an assigned time slot of a subsequent transmission period. The determined power level is forwarded to the BTS 12, and the BTS 12 uses this power level for the next downlink transmission to the mobile station 14.

The implemented algorithm is in particular able to deal with specific requirements in the case of USF blocks that have to be transmitted to a mobile station.

A time slot used in downlink transmissions can comprise an RLC block including user data and control data, an USF block assigning an uplink radio block to a mobile station, or both. In case a USF block and an RLC block are included in a single time slot, both blocks can be addressed to the same mobile station, e.g. mobile station 14 of figure 1. But equally, they may be directed at different mobile stations. The latter situation is illustrated in figure 2.

In figure 2, two mobile stations 21, 22 are connected to a BTS 12 of a GPRS network. The BTS 12 corresponds to the BTS of figure 1. The first mobile station 21 is located at a greater distance from the BTS 12 than the second mobile 22 station. In an equivalent situation, the first mobile 21 station has link conditions of a worse quality than the second mobile station 22. The BTS 12 now transmits a USF block to the first mobile station 21 and an RLC block to the second mobile 22 station using a single time slot. It has thus to be ensured that the power level assigned to this single time slot is sufficiently high for the mobile station 22 to which the RLC block is addressed and for the mobile station 21 to which the USF block is addressed. The worst case would be when the mobile station 22 which receives the RLC block is close to the BTS 12 or has good quality link conditions, while the mobile station 21 which receives the USF block is located far from the BTS 12 or has bad quality link conditions. The downlink power control algorithm therefore has to be able to detect such situations in order to be able to avoid loosing blocks in downlink transmissions.

Figure 3 is a flow chart of a part of the algorithm implemented in the PCU of figure 1.

The algorithm is based on three different threshold values. A first stored threshold value $USF\_quality\_level_{min}$ is the minimum quality level that is permitted by the operator for USF blocks. Two further threshold values $Qualtiy\_level_{min}$ and $Quality\_level_{max}$ constitute a lower and an upper quality limit for any other block. They are internally determined by quality thresholds for GPRS.

In order to determine the power level to be used for one time slot, measurement reports of the mobile stations to which blocks in this time slot are addressed are evaluated. Based on the included measurement results, a USF quality level required for the USF block and an RLC quality level required for the RLC block is determined, as will be explained further below.

In a first step of the depicted algorithm, the determined USF quality level is compared to the predetermined threshold value $USF\_quality\_level_{min}$. In case this minimum level is not ensured, the power level Pow that was used for transmitting the same time slot in the preceding transmission period is increased by a step D to a resulting power level Powout.

In case the determined USF quality level lies above the predetermined threshold value $USF\_quality\_level_{min}$, the minimum value set by the operator is ensured by the power level employed for the preceding transmission of the

corresponding time slot, and possible further adjustments of the power level are based on the determined RLC quality level. The corresponding evaluations are surrounded in the flow chart by a rectangle.

The determined RLC quality level is compared to the predetermined threshold value $Quality\_level_{max}$. In case this threshold value is exceeded, the power level Pow that was used for transmitting the same time slot in the preceding transmission period is decreased by a step D to a resulting power level Powout.

Otherwise, the determined RLC quality level is compared in addition to the predetermined threshold value $Quality\_level_{min}$. In case the determined RLC quality level lies below this threshold value, the power level Pow that was used for transmitting the same time slot in the preceding transmission period is increased by a step D to a resulting power level Powout.

Only in case the determined RLC quality level lies above the predetermined threshold value $Quality\_level_{min}$, no downlink power control has to be performed and the same power level that was used for transmitting the same time slot in the preceding transmission period is used again for transmitting the next time slot.

In case only an RLC block is to be transmitted in a time slot for which the power level is to be determined, the comparison of a USF quality level can be omitted.

The step size D used to update the BTS output power may be different for reducing and increasing the BTS output power. If this is the case, the step size used for increasing the output power should be larger than the step used for decreasing the output power, since the power reduction can imply a quality reduction as well.

In the following, it will be explained how the quality levels for USF blocks and RLC blocks can be determined based on the measurement values transmitted in quality reports from the mobile stations 14, 21, 22 to the BSS 11, 12.

In this embodiment of the invention, BLER values are used as quality levels. BLER values can be estimated based on the used modulation coding scheme and the measurements reported by the mobile station in a quality report to the BSS. Figure 4 illustrates a corresponding mapping of measurement values to a BLER value.

On the left hand side of figure 4, a table in form of a coordinate system is shown for EGPRS. The x-axis corresponds to the mean bit error probability mean(BEP), and the y-axis to the standard deviation of the bit error probability std(BEP). To each possible combination of mean(BEP) and std(BEP), a BLER value is assigned, taking account of the employed modulation scheme. The values of mean(BEP) and std(BEP) received by the mobile station for a downlink connection in a measurement report are mapped to a BLER value in the table. This is indicated in the table for one pair of parameter values and one resulting BLER by a filled black circle.

A similar table is shown on the right hand side of figure 4 for GPRS. In this case, the x-axis corresponds to the signal variance SIGN_VAR and the y-axis to the reception quality RXQUAL. As in the table for EGPRS, to each possible combination of values of the two parameters, a BLER value is assigned, taking account of the employed modulation scheme. The values of the signal variance and the reception quality received by the mobile station for a downlink connection in a measurement report are mapped to a BLER value in the table. This is indicated in the table again for one pair of parameter values and one resulting BLER by a filled black circle.

Such tables for GPRS and EGPRS are assembled for both, RLC blocks and USF blocks. They differ in the values of the BLER assigned to the respective combinations of received measurement values. The respective BLER values depend on the employed coding scheme, which is fixed.

The assembled tables are stored in the PCU 13 and consulted at the beginning of the downlink power control algorithm in order to determined the respective BLER values and thus the required RLC and USF quality levels.

The algorithm of figure 3 can be employed without any further considerations only in case recent quality measurements related to RLC and USF blocks are available.

Such a case is given in a first situation, in which RLC and USF blocks are addressed to the same mobile station. Both, RLC and USF quality levels, will be determined

based on downlink quality measurements made by this single mobile station in the established downlink and on mapping tables stored for RLC and USF mapping. These quality levels can be used in the algorithm of figure 3.

In a second situation, the RLC block and USF block are addressed to different mobile stations, as depicted in figure 2. Downlink quality measurements from the mobile station 22 that is to receive the RLC block are collected and converted into an RLC quality level. Moreover, it is assumed for the second situation that the mobile station 21 that is to receive the USF block has an established downlink, so downlink quality measurements related to the USF block can be collected from the last packet that was sent by this mobile station 21 for the downlink.

In case measurements values from the mobile station 21 that is to receive the USF block are available for the time slot of an immediately preceding transfer period, a valid USF quality level can be determined as well and be used together with the RLC quality level in the algorithm of figure 3.

In the described second situation, however, measurement values from the mobile station 21 which is to receive the USF block may not be transmitted every transfer period. Thus, it has to be avoided that measurement values that were not updated are used for adjusting the power for a following downlink transfer period. To this end, the BSC 11 includes a timer for each mobile station in transfer mode. The timers can be implemented using the frame numbers (FN).

The respective timer is started anew each time a packet with measurements from the assigned mobile station arrives at the BSS. The quality measurements are collected from the packet and the USF quality level is determined according to a stored mapping table as described above. A power level required for the transmission of the USF block is determined based on the USF quality level, similarly as in the respective part of the flow chart of figure 3.

This power level is increased according to the value of the timer at the time when the power level is to be set for a time slot comprising a USF block for the mobile station for which the USF quality level was determined. In addition, a power level required for the RLC block in the same time slot is determined based on the measurement values of the respective mobile station 22 for the time slot of the preceding transfer period, similarly as in the corresponding part of figure 3. The output power of the BTS is adjusted to the power level determined for the RLC block or to the increased power level for the USF block, whichever is higher. In case the timer expired before the power level is to be determined for a specific time slot, the time slot is transmitted with full output power.

Figure 5 is a coordinate system in which the output power to be determined for a USF block is depicted over the timer value beginning from a point of time at which the timer starts to a point of time at which the timer expires. In this system, two possible examples are shown

of how the BTS output power could change from the power value $Pot_{ACK/NACK}$ determined based on the measurements collected from the last packet to a maximum power value Pot_{max} while the timer is running. In both examples, the step by which the power is increased is fixed. In the first example, the transition function 51 is linear and thus the timer step is fixed as well. In the second example, the function 52 is a parabola, and the timer steps until the next increase in power are varying. The timer steps increase with the second function 52 with the timer value. For both cases, four steps from a first to a second power level are indicated.

The timer will be reset when the timer expires, when a new packet with measurements is collected and when the maximum power is reached by the BTS 12.

In a third situation, the RLC and USF blocks are addressed again to different mobile stations. In contrast to the second situation, however, the mobile station which is to receive the USF block has only an established uplink. This means that there are not downlink measurements except those which are sent in the measurement reports. The occurrence of these reports is very rare. Therefore in this situation, the most conservative solution is implemented, i.e. the blocks are transmitted with full power in order to avoid loosing USF blocks. Thus, the network has to detect in every moment whether a USF flag is addressed to a mobile station without established downlink.

A further special approach is provided in the downlink power control algorithm for determining the BTS output power that should be used for the first transfer period of a TBF that is to be established.

If the TBF is to use the same time slot and the same transceiver of the BTS as a previous TBF, the output power to be used for the first transfer period of the new TBF is determined based on the last output power that was used in the preceding TBF.

In case a long time passes between two consecutive downlink TBFs, however, it is does not make sense to use simply the last power level employed for the last TBF, since the radio link conditions may have changed. Instead, the timer that was defined above in order to solve the USF limitation is employed also in this situation.

The above cited specification 04.60 already proposes two other timers for a GPRS/EGPRS system.

To each TBF, a Temporary Flow Identity (TFI) is assigned by the network. The mobile station assumes that the TFI value is unique among concurrent TBFs in the same direction, i.e. uplink or downlink, on all PDCHs used for the TBF. A first timer T3192 on the mobile station side waits for the release of a TBF after reception of the final block. This timer is started when the mobile station has received all RLC data blocks. When the timer expires, the mobile station releases the resources

associated with the current TBF, e.g. the TFI, and begin to monitor its paging channel.

A second timer T3193 on the network side waits for the reuse of a TFI after the reception of a final packet downlink Ack/Nack from the mobile station. This timer is used to define the point of time at which the timer T3192 has surely expired so that the TFI can be reused. Its value is network dependent.

After reception of the final packet with measurements in the last TBF, the proposed new timer starts. While the new timer is running and timer T3193 has not expired, the output power applied in the first transfer period in the next TBF depends on the time elapsed since the start of the timer. The output power can be increased with time as described with reference to USF and figure 5. After the new timer or the timer T3193 has expired, the BTS shall transmit with full output power for the first transfer period in the next TBF.

If there is a downlink TBF reallocation to a transceiver different from the previously employed transceiver, the BTS could transmit immediately with maximum power.

The presented embodiment of the invention, however, is based on another approach for the case that a new TBF uses another time slot or another transceiver than a previous TBF. In this approach, it is ensured that the BTS transmits at least with a power value that assures a predetermined receiving power level Rxlev for the mobile station.

To this end, a new operator parameter Min_Rxlev_GPRS_DL is introduced. The value of this parameter is the minimum receiving power level that the mobile has to receive in order to be able to decode the signal correctly. The BTS output power will have to guarantee this Rxlev value at least for the first transfer period.

First, the path loss is calculated for the mobile station that has established the TBF. The calculation is based on the last receiving power level Last_Rxlev and the last power value Last_Power used for the previous TBF:

$$Path\_Loss = Last\_Power - Last\_Rxlev$$

Then, the transmission power level required to assure the minimum receiving power level for GPRS downlink transmissions Min_Rxlev_GPRS_DL for this mobile station is calculated based on the determined path loss:

$$Power(Min\_Rxlev\_GPRS\_DL) = Min\_Rxlev\_GPRS\_DL + Path\_Loss$$

Finally, the required BTS output power is estimated based on this calculated transmission power and a variable value f(time_between_TBFs). The variable value is controlled by the same timer which is used when the re-establishment occurs in the same TBF as described above. The variable value changes the power depending on the time elapsed between the end of a TBF and the start of the next one according to the equation:

$$BTS\_Output\_Power = Power(Min\_Rxlev\_GPRS\_DL) + f(time\_between\_TBFs)$$

Figure 6 shows again a coordinate system in which the output power is depicted over the timer value, which indicates in this case the time between an old and a new TBF. It shows how the power is increased according to a linear function 61 in equal steps of time beginning from the time the timer is started. The maximum value of the function, which is reached when the timer expires, is normalized in order to assure that the maximum value for the sum is full power Pmax-P. Again, four steps from a first to a second power level are indicated.

The new operator parameter Min_Rxlev_GPRS_DL which constitutes the minimum receiving power level required at a mobile station for downlink transmissions in a GPRS system needs to be optimized. But since all TBFs start with the same coding scheme, the parameter requires only one Automatic Parameter Optimization.

In the whole, the invention enables a downlink power control which is suited to solve two problems, i.e. the USF limitation and the determination of an output power for a first transfer period, with only one timer.

Claims

1. Method for controlling in a general packet radio service (GPRS) and/or enhanced GPRS (EGPRS) network (11-13) the power level employed for downlink transmissions from said network (11-13) to at least one mobile station (14,21,22), said method comprising adjusting said power level for a downlink transmission based on at least one measurement value indicating the quality of a radio link to be used for said downlink transmission to said at least one mobile station (14,21,22), which at least one measurement value was measured at said at least one mobile station (14,21,22) for a preceding downlink transmission and transmitted by said at least one mobile station (14,21,22) to said network (11-13).

2. Method according to claim 1, wherein a quality level corresponding to said at least one measurement value is compared to a minimum value predetermined in said network (11-13) and to a maximum value predetermined in said network (11-13), and wherein for adjusting said power level a transmission power employed for said preceding downlink transmission to said mobile station (14,21,22) is increased in case said quality level is lower than said minimum value and decreased in case said quality level is higher than said maximum value.

3. Method according to claim 2, wherein said quality level consists of a composite quality value, a single quality value or a power level value.

4. Method according to claim 2, wherein said quality level consists of a block error rate (BLER) determined based on said measurement values received from said at least one mobile station (11,21,22).

5. Method according to one of the preceding claims, wherein said power level is adjusted for each time slot of a transfer period employed for downlink transmissions, and wherein said at least one measurement value is determined by said at least one mobile station (14,21,22) for a corresponding time slot in a preceding transfer period.

6. Method according to one of the preceding claims, wherein in case said downlink transmission for which said power level is to be adjusted comprises at least an uplink state flag (USF) block, and in case a mobile station (21) to which only said USF block is to be transmitted has an established downlink to said network (11-13), said power level is determined based on said measurement values for a preceding downlink transmission to said mobile station (21) and on the time elapsed since said measurement values were received at said network (11-13).

7. Method according to claim one of the preceding claims, wherein in case said downlink transmission for which said power level is to be adjusted comprises at least an uplink state flag (USF) block

and in case a mobile station (21) to which said USF block is to be transmitted has only an established uplink to said network (11-13), said USF block is transmitted with a predetermined maximum power to said mobile station (21).

8. Method according to one of the preceding claims, wherein in case a power level is to be determined for a downlink transmission comprising blocks addressed to at least two different mobile stations (21,22), said power level is adjusted to the highest power level required for one of said mobile stations (21,22) according to measurement values provided by each of said at least two different mobile stations (21,22).

9. Method according to one of the preceding claims, further comprising in case a power level is to be determined for a downlink transmission comprising an uplink state flag (USF) block and an radio link control (RLC) block addressed to a single or to two different mobile stations (14,21,22), which determination proceeds from a power level employed for a preceding downlink transmission to said single or two different mobile stations (14,21,22):
- determining a USF quality level based on measurement values for a preceding downlink transmission measured and transmitted by a mobile station (14,21) to which said USF block is addressed;
- determining an RLC quality level based on measurement values for a preceding downlink transmission measured and transmitted by a mobile

station (14,22) to which said RLC block is addressed;

- increasing said power level employed for said preceding downlink transmission in case said USF quality level is below a first predetermined threshold value;
- otherwise reducing said power level employed for said preceding downlink transmission in case said RLC quality level is above a second predetermined threshold value;
- otherwise increasing said power level employed for said preceding downlink transmission in case said RLC quality level is below a third predetermined threshold value.

10. Method according to one of the preceding claims, wherein for a new temporary block flow (TBF) in the downlink using the same transceiver and the same time slot that were employed for a preceding TBF, the first transfer period of the new TBF is transmitted with a power level depending on the power level employed for the last transmission of the preceding TBF and the time elapsed since the last transmission of the preceding TBF.

11. Method according to one of the preceding claims, wherein for a new temporary block flow (TBF) in the downlink using another transceiver or another time slot than were employed for a preceding TBF, a predetermined maximum power level is employed for a first transmission.

12. Method according to one of the preceding claims, wherein for a new temporary block flow (TBF) in the downlink using another transceiver or another time slot than were employed for a preceding TBF, a power level to be used for a first transmission for said new TBF is determined based on a minimum power level required at said mobile station (11,21,22), on a path loss determined for said preceding TBF to said mobile station (11,21,22), and on a time elapsed between a last transmission for said preceding TBF and a first transmission for said new TBF.

13. General packet radio service (GPRS) and/or enhanced GPRS (EGPRS) network comprising a base station controller (BSC) (11) connected to a base transceiver station (BTS) (12), via which BTS (12) radio links are established between said network and mobile stations (14,21,22), wherein said GPRS and/or EGPRS network further comprises in a network element (11) a packet control unit (PCU) (13) with means for adjusting a power level employed by said BTS (12) for downlink transmissions according to one of the preceding claims.

14. GPRS and/or EGPRS network according to claim 13, characterized by at least one timer for determining the time passed between a point of time at which measurement values from at least one mobile station (21) were received at said network and a point of time at which said power level is to be determined and/or for determining the time passed between a point of time at which the last temporary block flow (TBF) was transmitted by said network and a point of

time at which a new temporary block flow (TBF) is to be transmitted, wherein said PCU (13) has access to the value of said at least one timer.

15. Packet control unit (PCU) (13) for a network element (11) of a general packet radio service (GPRS) and/or enhanced GPRS (EGPRS) network comprising means for adjusting a power level employed by a BTS (12) of said network for downlink transmissions according to one of claims 1 to 12.

16. Packet control unit (13) according to claim 15, characterized by at least one timer for determining the time passed between a point of time at which measurement values from at least one mobile station (21) were received at said network and a point of time at which said power level is to be determined and/or for determining the time passed between a point of time at which the last temporary block flow (TBF) was transmitted by said network and a point of time at which a new temporary block flow (TBF) is to be transmitted.

17. Storing medium in which a software with a downlink power control algorithm is stored, which software performs the steps of the method according to one of claims 1 to 12 when said software is implemented in a packet control unit (PCU) (13) of a network element (11) of a general packet radio service (GPRS) and/or enhanced GPRS (EGPRS) network.

18. Software comprising a downlink power control algorithm, which software performs the steps of the

method according to one of claims 1 to 12 when said software is implemented in a packet control unit (PCU) (13) of a network element (11) of a general packet radio service (GPRS) and/or enhanced GPRS (EGPRS) network.

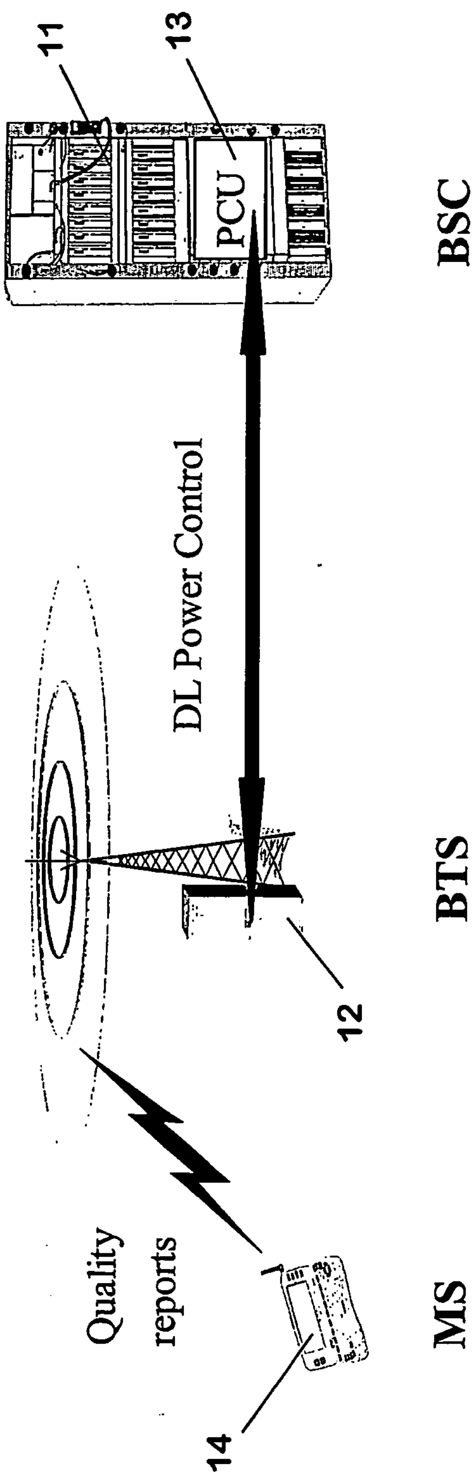

FIG. 1

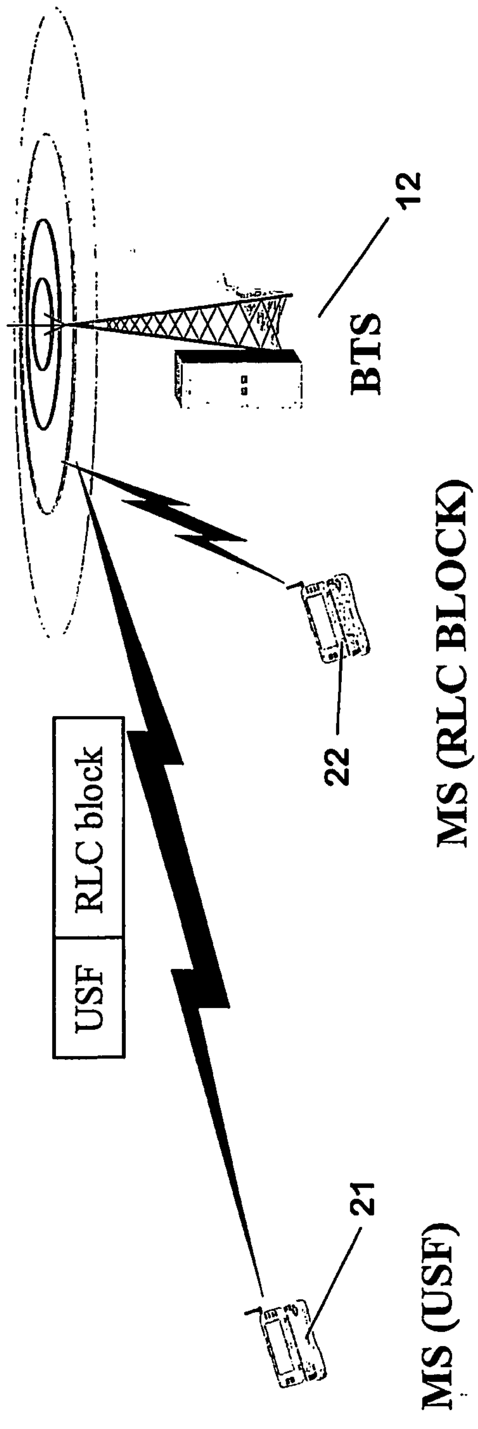

FIG. 2

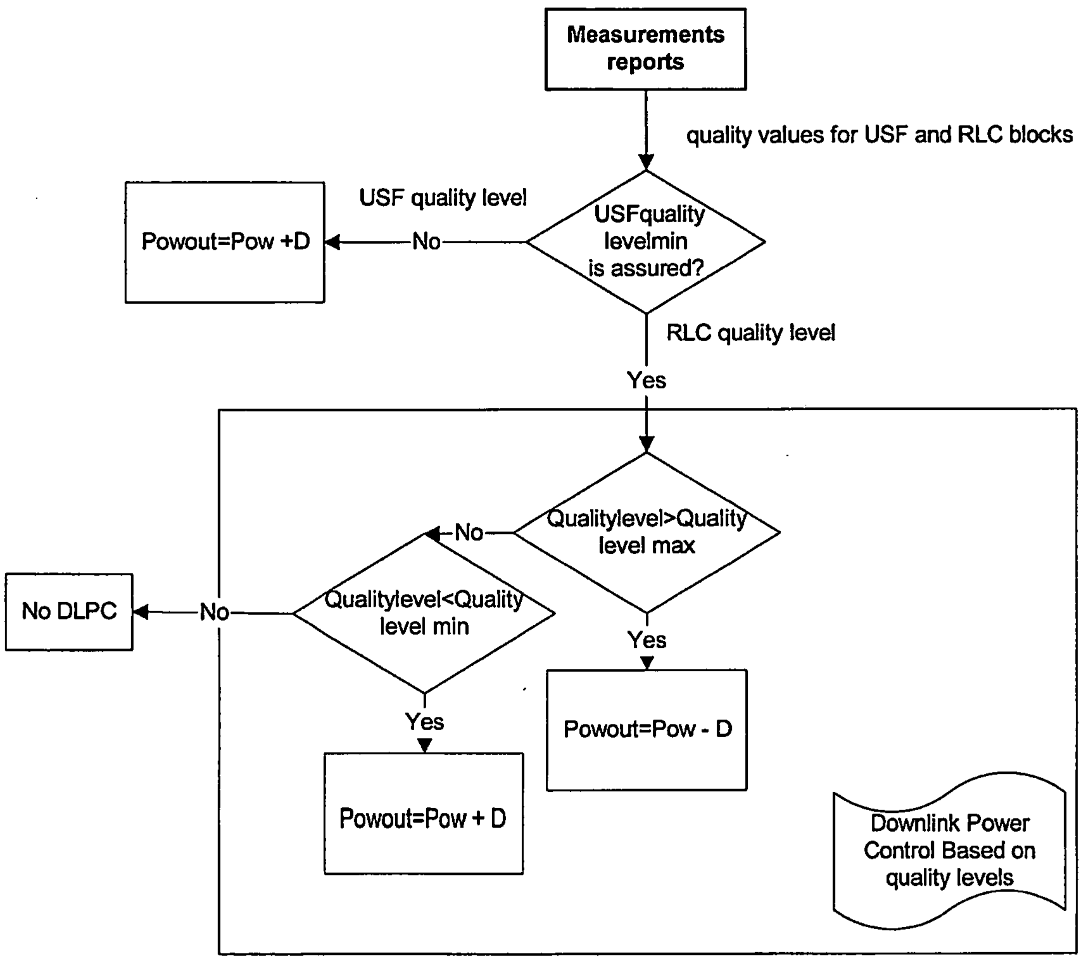
Measurements reports
quality values for USF and RLC blocks
USF quality level
Powout=Pow +D
No
USFquality levelmin is assured?
RLC quality level
Yes
No
Qualitylevel>Quality level max
No DLPC
No
Qualitylevel<Quality level min
Yes
Yes
Powout=Pow - D
Powout=Pow + D
Downlink Power Control Based on quality levels

FIG. 3

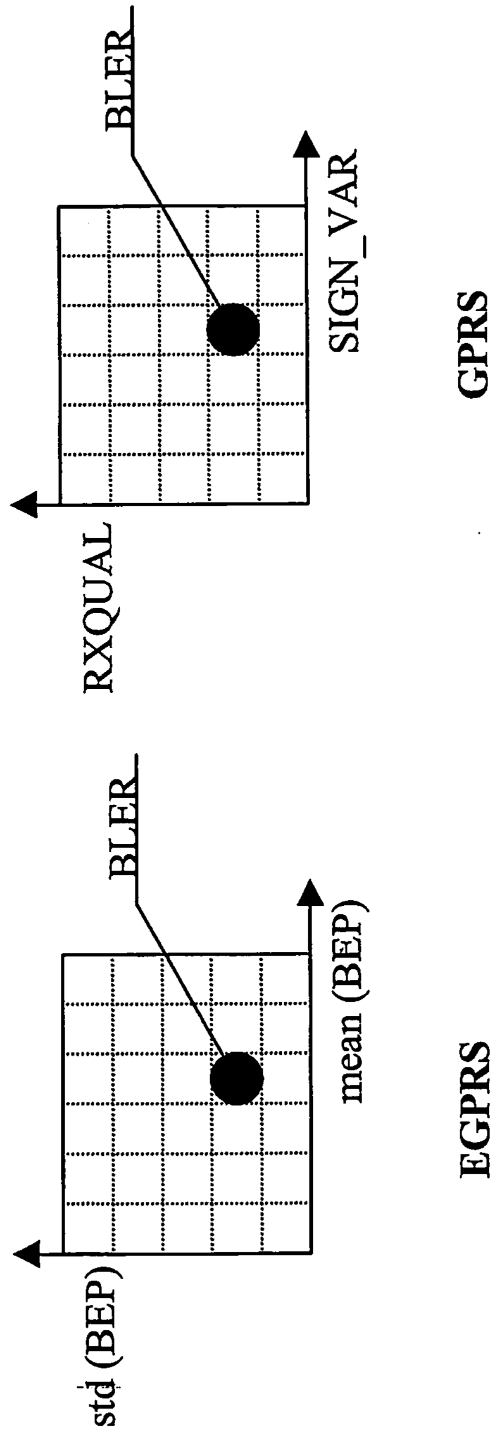

FIG. 4

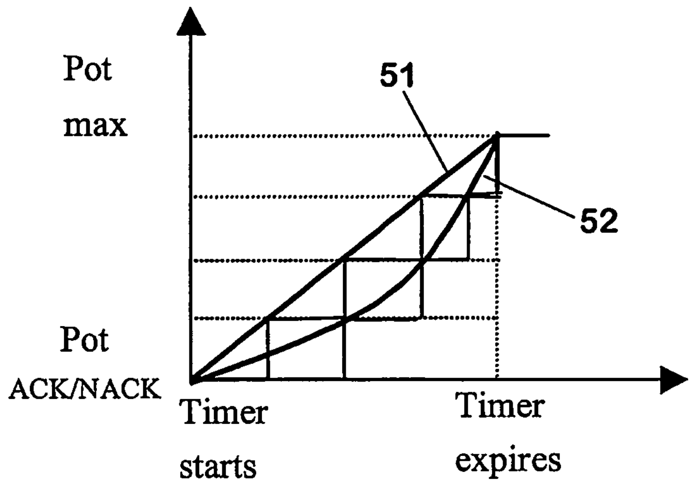
Pot
max
51
52
Pot
ACK/NACK
Timer
starts
Timer
expires

FIG. 5

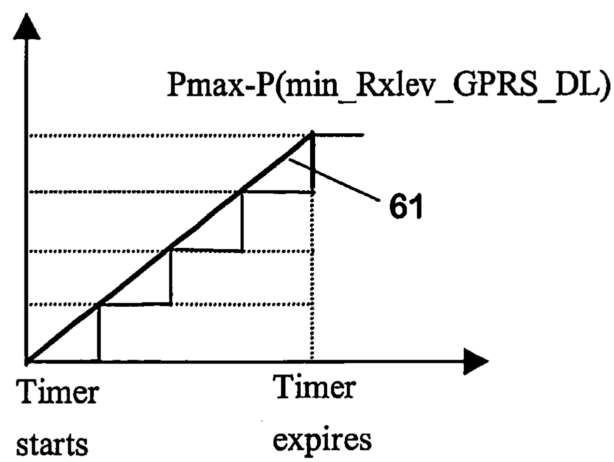
Pmax-P(min_Rxlev_GPRS_DL)
61
Timer
starts
Timer
expires

FIG. 6